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Hydro-Electric Power Commission

OF THE

Province of Ontario

THIRD REPORT

LAKE HURON AND GEORGIAN BAY DISTRICT

Printed by Order of the Legislative Assembly of Ontario,
September 10th, 1906

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Hydro-Electric Power Commission

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Province of Ontario

THIRD REPORT

LAKE HURON AND GEORGIAN BAY DISTRICT

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COMMISSION.

HON. ADAM BECK, London, Chairman.
GEO. PATTINSON, M.P.P., Preston.
JOHN MILNE, Hamilton.

STAFF—

CECIL B. SMITH.....*Chief Engineer.*
S. B. CLEMENT.....*Asst. Engineer.*
W. G. CHACE.....*Asst. Engineer.*
E. RICHARDS.....*Electrical Engineer.*
C. P. FOWLER.....*Electrical Engineer.*
H. G. ACRES.....*Hydraulic Engineer.*
GORDON SPROULE.....*Secretary.*

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THIRD REPORT.

LAKE HURON AND GEORGIAN BAY DISTRICT.

To his Honour,
The Lieutenant-Governor of Ontario:—

The undersigned Commissioners appointed by your Honour by Commission bearing date the 26th day of January, 1906, beg leave to submit the following report, as their third report upon the matters authorized and directed to be enquired into.

Your Commissioners made enquiries and obtained information from various sources, but did not find it necessary to hold formal sittings in this district, as the information which they have obtained has been given freely to members of their engineering staff, who have thoroughly canvassed this district both as to its hydraulic possibilities and its present industrial demands.

Your Commissioners have forborne to give in detail the names of their informants or the particulars of the information acquired from them, but have used the knowledge and facts so acquired for the purposes of computation, comparison, etc., and for the production of the results which they have now the honour to report.

The detailed scientific and technical information obtained has been tabulated and arranged by the Engineer employed by your Commissioners and is contained in his report which is submitted as an appendix hereto.

The following are the matters on which your Commissioners were authorized and directed to report, with the report upon each subjoined:—

DEMAND FOR ELECTRIC POWER.

(1) *"The present and probable demand for hydraulic and electrical power in the various districts capable of being supplied from the different waterpowers within the jurisdiction of the Province of Ontario."*

In this third report your Commissioners deal with that portion of Ontario bounded on the west by Lake Huron and Georgian Bay, and on the south, east and north by the districts covered by the Niagara and Trent reports already issued and by the watershed of the Ottawa River, and which, for the purposes of this report, may be called, The Lake Huron and Georgian Bay District. For convenience, the towns in this district have been assembled into four groups,

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although the specific transmission schemes estimated upon do not apply to the groups as so made up, the subdivisions being geographical only.

The demand for electrical power will, in almost all cases, depend upon the relative cost of electricity as compared with that of steam, gas or other local source of power. The cost of electricity is dependent upon the distance over which it is transmitted and upon the quantity transmitted. As it is only feasible to transmit the power in large quantities, trunk transmission lines capable of carrying large quantities must be constructed at the outset; therefore the cost increases with the distance, and a point is eventually reached at such a distance from the generating station that electrical can no longer compete with steam or other local power.

Again the exhaust steam and heat from the steam plant of some factories is used in the process of manufacture, and it could not be expected that electricity would be adopted by manufacturers of this class for power only, as their production of steam and heat for manufacturing purposes apart from power would increase rather than diminish their expenses; and in many instances waste material is used in the production of steam; such industries have been excluded from the consideration of the extent of the market at present in sight. The capital cost of abandoning steam plants would also, in many cases, be considerable, and the ability of small users of power to bear this loss must always be a factor in the finding of a market.

Experience shows that where the distribution is controlled by private corporations, the distribution area remains restricted, and from the information obtained by your Commissioners they are able to say that the trend of affairs with private Corporations has been, not to compete for business and thus keep down prices to consumers, but to amalgamate or otherwise destroy competition, and then to fix the prices according to the slight saving which they may be able to induce particular customers to make. The natural result of this has been to force individual consumers, where the circumstances justified it, to instal generating plants of their own, or to adhere to existing methods, rather than to place themselves at the mercy of large combinations formed for the purpose of preventing competition and keeping up the price of electrical power.

As a result, however, of your Commissioners' enquiries in the various manufacturing centres of this district as to the present and probable market for electric power, it appears that under favourable conditions a total demand of 16,000 H.P. is at present existent. Of this total a considerable proportion can be supplied locally, or is already supplied locally or by transmission systems already constructed as indicated in the engineer's appendix. Again in some small scattered towns at a distance from water-powers there does not appear to be any opportunity to meet the small probable demands.

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Aside from these, however, the power market dealt with in the Engineer's report totals some 12,800 H.P., the hydraulic supply for which is limited and could not take care of large increments, either industrial or for the operation of electric railways. This may become of importance in relation to the distribution of power from the Severn River, for, should Midland or Victoria Harbour make large demands for power beyond the market already in sight, either the supply of electric power to Meaford and Owen Sound would have to be abandoned or else further water-powers on the Moon or Muskoka River, some 10 to 15 miles north of the Big Chute of the Severn River, could be developed and operated in conjunction with those already studied at Big Chute and Eugenia Falls.

In connection with the Engineer's report recommending a common operation of the above mentioned water-powers it should be noted that the Georgian Bay Power Co., is already doing some work at Eugenia Falls, and it is hoped that this work will be carried on with a view to the future, by constructing large head works and pondage and installing machinery in large units so that allied operation with Big Chute power may become practicable.

Your Commissioners are convinced that there is now a market for the amounts of power above stated, and therefore, that if deliveries are based on 4% interest, the prices indicated in the Engineer's report can be made to the various municipalities as soon as the necessary works are constructed.

UNDEVELOPED LOCATIONS.

(2) "*The location, capacity, and capital cost of development of the various water-powers within the legislative jurisdiction of the Province of Ontario at present undeveloped, but whose development is required to supply the present and probable needs of the surrounding districts, and to ascertain the cost of the attendant transmission plant necessary to the utilization of electrical and hydraulic powers to be provided from the aforesaid water-powers within the respective surrounding districts.*"

A systematic tabulation of the water-powers of the various rivers in this district based upon gaugings and meterings, supplemented by information derived from other sources, has been carried out during the past year, and although more minute information, particularly with reference to dry weather flow, could be obtained by continuing the work, it is felt that a fairly accurate hydraulic knowledge of the district has been obtained.

In the southern portion of this district the rivers do not possess natural storage, and to develop such beyond that required for daily

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variations of load is financially impracticable; thus for water power developments in this area the cost per horse power of dry weather capacity will be high and there will be a tendency to instal more machinery than can be operated during low water periods, the deficiency being made up in some cases by auxiliary steam equipment.

The proposed development on the Maitland river is now being promoted by the Maitland River Power Co. and there is already a small power plant near the mouth of the Saugeen River which would be abandoned in case the larger one were gone on with.

Also at Eugenia Falls a Company is now commencing construction, and it is much to be desired that the development at the Big Chute of the Severn River should be constructed by allied interests tending to ultimate economy in serving the Georgian Bay towns within transmission distance from these two water powers.

North of the Severn River many good natural water powers exist and they will doubtless be developed from time to time as needs arise; but at the present time the only town of importance not yet supplied or which has not water power in its vicinity is North Bay, for which a suggested source is the South River, although a much larger development could be made at the Chaudiere Falls of the French River, involving, however, a very long transmission not warranted by the present demand for power. It is considered that the undeveloped powers on the Sturgeon River will be required in the future at Sturgeon Falls, and that the water powers of the Mattawa are not available for development at present owing to the Dominion Government having now under consideration the Georgian Bay Ship Canal which might require the whole dry weather flow of this river for canal purposes. As shown in the Engineer's report, Table V, there are many undeveloped locations of considerable magnitude for whose power there is at present no near market; these are located on the Moon, Muskoka, Maganetawan, French and Wahnapitæ Rivers. The natural uses to which these powers might some day be devoted would be pulp grinding, wood working manufactures, or ultimately the operating of railways now operated by steam.

Your Commissioners, having considered the present requirements of the district, herewith present detailed estimates of the capital costs and annual charges of five hydro-electric developments of a total nominal capacity 9,950 H.P. for which see Part IV of the Engineer's report; and, in connection therewith, have caused careful studies to be made, and now present detailed estimates of the capital costs and annual charges, etc., of transmission systems and substations necessary to deliver this power to various municipalities, and also some 3,900 additional horse power from Niagara Falls to meet a demand for power in localities which it has not been found feasible to supply from water powers of this district. Part V of the Engineer's report contains this information.

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RATES AND PRICES.

(3) *"To ascertain the rates or prices that would require to be charged the various classes of consumers of hydraulic or electrical power within the respective districts in order to meet all expenditure of maintenance and operation."*

The ascertainment of the rates that would require to be charged for electrical power in order to meet expenditure of maintenance and operation is based upon the cost of necessary plant for future calls upon it, original cost of construction, cost of maintenance and operation, and the probable market for electrical power, ascertained from local enquiries.

In order to ascertain the cost of delivering electrical power in large quantities at particular distances, your Commissioners have made computations with respect to all the municipalities (as localities and not as corporate bodies) which could be conveniently and economically supplied from five generating plants through transmission systems and sub-stations estimated on in Part V of the Engineer's report, supplemented by some additional power from Niagara Falls. It should be particularly noted that the basis of estimate is not the total present power consumed in the various manufacturing centres; but that portion which the Commission's Engineers, after consideration, denote as being probably available as customers, if electrical power were offered at reasonable rates.

The calculations have been three-fold:

1st—Present available market plus 25% arbitrary increase to allow for growth until such time as installations of transmission systems can be completed.

2nd—75% of this arbitrary total.

4th—50% of this arbitrary total.

Your Commissioners call attention to the fact, however, that when electricity is delivered at a municipal sub-station, as above, the cost of distribution among the consumers within such municipality must be added to this price in order to determine the cost to the individual municipal consumer.

In order to illustrate the cost of distributing power delivered at a sub-station your Commissioners have caused estimate to be made for a distribution system for the town of Collingwood as typical for towns in this district, and in Part VI of the Engineer's report will be found the results obtained, but it must be understood that local conditions, the proportionate amounts of lighting and power, and the variety of industries, hours of operation, etc., all point to the necessity of special local studies being made for each municipality.

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Table XXII, Part V, also gives data in regard to the cost of supplying a particular customer with power at a considerable distance from a sub-station, the total cost to such a consumer being the sub-station cost added to the secondary cost given in the table.

SAVINGS.

(4) "*To enquire into and ascertain the annual savings accruing to the consumers in the various districts aforesaid by the substitution of the rates or prices in the next preceding paragraph for the rates paid at present in the said district so far as the Commissioners may be able to ascertain or estimate them.*"

The estimated savings obtained by comparing the present conditions under steam operation with those obtainable by using electrical power supplied on the basis of the engineer's estimate is given in Part XII. for the town of Collingwood, as typical of this district; it must be understood, however, that this is on a 4% basis, and will not hold true if the electrical power is transmitted and distributed by private companies from, or including the generating station, as these companies will only make such rates as will barely induce consumers to change from steam to electrical operation by reason of greater cleanliness, convenience, etc.

The annual amount of savings which might accrue is very difficult to estimate because each town has its peculiarities. If some industries could be encouraged sufficiently by cheap power they might operate 24 hours per day; others might be willing to give limited hour contracts for the winter season; and the town pumping, if done by the municipality, and where reservoir capacity is available, might also be done chiefly by night. All these factors have such an intimate bearing on the solution that any estimate can only be considered approximate. However, the estimates given in Part XII. of the Engineer's report are considered to be conservative.

CAPITAL COST OF UNDERTAKINGS.

(5) "*To enquire into and ascertain the cash capital cost of the hydraulic and electrical power undertakings of existing companies located within the Province of Ontario, the capacity and state of development thereof.*"

Your Commissioners considered that to enquire into the capital costs of ordinary electric lighting stations operated by water power adjacent to its distributing area would not be of any particular value for this report, as the evident intention and aim of the Commission's enquiries were to determine these matters with respect to larger undertakings, generating electrical energy both for purposes of power and light, and transmitting the same some distance.

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The undertakings at present doing a business of this character in this district are situated at Sturgeon Falls, Sudbury, Bracebridge, and Orillia.

Sturgeon Falls electric installation is made by the Imperial Paper Co., and outside of some 210 H.P. for town lighting distributes 830 H.P. for operation in its own mills. The cost of this installation would be difficult to determine outside of machinery costs, as it is only a portion of a much larger installation for pulp grinding direct by turbines.

Sudbury is supplied with its electric power from the Wahnapitae River some 10 miles distant. The power plant is built with permanent works of 4,000 H.P. capacity, power house of 2,130 H.P. capacity and generating machinery of 1,065 H.P. capacity, it delivers at the present time 200 H.P. in Sudbury. The present cost is $120,000.00 including transmission system and transformer stations.

Bracebridge owns a municipal power station of 665 H.P. from which at the present time is sold some 600 H.P. The capital cost to date has been $75.500.

Orillia owns a municipal power station of 2,400 H.P. capacity with machinery installed for 1,600 H.P. The sales at the present time being close to the capacity, and the installation of the 800 H.P. additional of machinery is now in progress. The complete cost to date of power station and transmission system, with some distribution is $250,000.

The above described constructions are none of great magnitude, but as they are all naturally easy developments, the capital cost per H.P. and annual charges are moderate except in the case of the Ragged Rapids plant of the town of Orillia which, owing to unfortunate incidents in connection with construction, has cost more than it should have cost.

POWER SUPPLIED AND UNDER CONTRACT BY THE EXISTING COMPANIES.

(a) *"The quantities supplied and contracted for and the rates charged and to be charged under such contracts by these companies for hydraulic and electrical power."*

In Part II. of the Engineer's report, Table V., will be found listed the amount of machinery installed at various points. It will be noted that in most cases the installations are for flour or for other mill work or for generation of electric energy for town lighting. In only three or four instances are any considerable amounts of electrical energy supplied for power purposes.

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The prices or rates charged for power and light in various municipalities are set forth in Part IX. It will be noted that the charges for light by municipal plants are uniformly lower than those under private control and that the price for power at Bracebridge and Orillia is much less than at Sudbury where a privately owned power Company supplies power to the town.

APPRAISEMENT OF UNDERTAKINGS

(b) "*The actual present value of the said undertakings, or such of them as may be required, after making such fair and reasonable allowances for existing conditions as in the judgment of the Commissioners seems necessary or expedient.*"

See Part V. of Commissioners' report.

(c) "*To estimate the capital outlay, if any, necessary to complete these undertakings.*"

At the present time the town of Orillia is proceeding to expend some $80,000 additional in the construction of a permanent dam and increase of generating machinery from 1,600 H.P. to 2,400 H.P.

The town of Bracebridge is expending $14,000 in increasing its generating capacity from 330 H.P. to 660 H.P.

The Wahnapitae Power Co. can when desired add to its machinery capacity increasing it from 1,065 H.P. to 2,130 H.P. by an expenditure of about $18,000.

At Eugenia Falls, on the Beaver River construction is just being commenced by the Georgian Bay Power Co., and near Goderich, on the Maitland River, the Maitland Power Co. is promoting the construction of the power plant outlined in Part V. of the Engineer's report.

CONCLUDING REMARKS.

Your Commissioners respectfully submit that in the thickly settled portions of this district water powers are scarce and limited, and valuable, a demand exists now for all the power which can be conveniently produced; in the near future demands will be made, in all probability, on the water powers of the Muskoka River for transmission to supplement the available power of the Severn and Beaver Rivers. It therefore is imperative that the water powers of the Severn, Muskoka, or other rivers not yet leased by the Crown, be retained for the use of the many municipalities which must, for all time, depend on these sources for whatever electrical energy they may obtain from water power, and should any lease of water power be granted in the future such lease should specify the rates at which the Hydro-Electric Power Commission may obtain electric power in

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a condition and quantity at the generating plants ready for transmission, or at the points of delivery in the various municipalities.

This is particularly applicable with respect to the Georgian Bay towns where, if any widespread benefit is to be obtained, the concerted action of all the municipalities interested is necessary, as a private company would be interested in selling as much of the power as possible in those towns located near the water power, at rates which would approach as nearly as possible to coal produced rates; thus giving a maximum of profit to the Company and a minimum of benefit to the customers, leaving the more distant towns for all time without any benefit.

All of which is respecfully submitted.

(Sgd.) ADAM BECK,
Chairman.
(Sgd.) GEORGE PATTINSON,
(Sgd.) JOHN MILNE.

TORONTO, September 10th, 1906.

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APPENDIX

TO

THIRD REPORT

Lake Huron and Georgian Bay District

ENGINEER'S REPORT

ON

THE GENERATION, TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER

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HONOURABLE ADAM BECK,

CHAIRMAN OF THE HYDRO-ELECTRIC POWER COMMISSION:

DEAR SIR,—

Herewith find my report on the Lake Huron and Georgian Bay district, extending as far north as Wahnapitae River and the town of Sudbury.

The report deals with the present demand for power within economical transmission distance of various water powers, and with the cost of generating and transmitting electrical energy within this area, based on 4% return on investment.

Yours respectfully,

CECIL B. SMITH,
Chief Engineer.

TORONTO, CANADA,
AUGUST 23RD, 1906.

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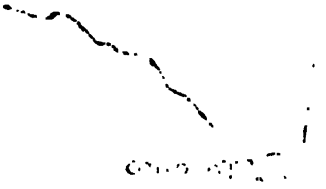
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PART I.

GEOGRAPHICAL SUB-DIVISIONS.

In that portion of Ontario adjacent to Lake Huron and Georgian Bay, and over the interior of western Ontario, north of the district already covered by the Niagara Report, there is a large number of small towns scattered somewhat uniformly over the entire area as far north as the Severn River, while north of this there is a very sparse population with few towns, but adjacent to several of which are found water-powers sufficiently extensive to supply all their present needs.

The water-powers of the southern portion of this district are not very extensive and are widely scattered, leaving the central or interior territory at a disadvantage as regards delivery of electric power at reasonable rates, not only because of distance from source of supply, but also because of the small demand existing at any one point, making transmission relatively expensive, and even, in some cases, quite impracticable under present conditions.

In view of the above described conditions it has been found necessary to extend somewhat the sphere of influence of Niagara Falls, as will be noted later on, and it is proposed to carry a secondary transmission line from Berlin to meet the requirements of Elmira, Elora and Fergus, and from Toronto to Aurora and Newmarket.

PART II.

DEMANDS FOR POWER.

As a basis for estimates a full canvass was made by expert assistants in each town of this district. In this canvass care was taken to determine whether or not the consumer would be likely to adopt electric power if it were available at reasonable rates; the canvass included also present users of hydraulic and electric power. In the tables following, these various classes of consumers are tabulated, so that an estimate can be arrived at of the market available in the imme-

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diate future for electric power, and in Tables I, II, III and IV this information is set forth in detail.

The map accompanying this report indicates the location of the chief water-powers on the Wahnapitae, Sturgeon, French, South, Muskoka, Severn, Beaver, Saugeen and Maitland Rivers, and, as shown thereon, specific transmission schemes have been adopted by which certain of the present available markets may be supplied from these water-powers.

Detailed estimates, etc., in connection with these transmission schemes will be found worked out in this report.

It will be noted that many of the smaller towns have not been taken into consideration, in some cases because the present consumption would not warrant the necessary expenditure, in some because the towns are already partially or entirely supplied locally, and in others because the amount of water-power available has not been found sufficient to meet all probable demands.

TABLE I.

POWER CONDITIONS.

INLAND TOWNS.

Municipality	Pop.	Total amount power used. H.P.	Amount available for electric installation. H.P.	Suggested or present source of power.
Newmarket	2700	1050	500	Niagara River.
Aurora	2000	410	300	" "
Fergus	1600	275	150	" "
Elora	1400	305	100	" "
Elmira	1200	350	300	" "
Exeter	1800	322	250	.....
Mitchell	2200	305	200	Maitland River.
Seaforth	2500	475	350	" "
Clinton	2800	410	200	" "
Brussels	1400	290	175	" " (local)
Wingham	2400	440	200	" " (local)
Listowel	2500	465	400	.....
Palmerston	2700	350	180	.....
Arthur	1300	225	200	.....
Harriston	1800	270	150	.....
Mount Forest	2400	315	100	.....
Dundalk Shelburne	2100	400	300	Beaver River.
Alliston	1300	350	....	.....
Barrie	7000	940	500	Severn River.
Durham	1700	900	600	Saugeen River (local)
Hanover	1800	550	....	" " "
Walkerton	3000	150	....	" " "
Teeswater	1300	285	65	" " "
Lucknow	1100	286	150	Nine Mile River "
Paisley	1000	200	....	Saugeen River "
Chesley	1800	340	....	" " "
Orillia	6000	1525	1100	Severn River.

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TABLE II.

POWER CONDITIONS.

MUSKOKA, PARRY SOUND AND NIPISSING DISTRICTS.

Municipality.	Pop.	Total amount power used. H.P.	Amount available for electric installation H.P.	Suggested or present source of power.
Gravenhurst	2200	235	200	Muskoka River.
Bracebridge	2500	1240	660	" " (local)
Huntsville	2500	1220	220	" "
Burk's Falls	800	575	150	Maganetawan River.
Parry Sound	3500	1135	60	Sequin River (local)
North Bay	3750	500	450	South River.
Sturgeon Falls	3000	6500	210	Sturgeon River (local)
Sudbury	2400	260	210	Wahnapitae River.

TABLE III.

POWER CONDITIONS.

LAKE HURON TOWNS.

Municipality.	Pop.	Total amount power used. H.P.	Amount available for electric installation H.P.	Suggested or present source of power.
Goderich	4300	1450	500	Maitland River.
Kincardine	2800	450	300	.....
Port Elgin	1500	....	100	Saugeen River.
Southampton	1800	400	100	" "

TABLE IV.

POWER CONDITIONS.

GEORGIAN BAY TOWNS.

Municipality.	Pop.	Total amount power used. H.P.	Amount available for electric installation H.P.	Suggested or present source of power.
Wiarton	2400	1200	200	.....
Shallow Lake	600	1000	700	Saugeen River.
Owen Sound	10000	3750	2000	Beaver and Severn Rivers
Meaford	2800	700	250	" " " "
Collingwood	7000	1650	1000	" " " "
Penetang	2800	600	200	" " " "
Midland	3500	1400	650	" " " "
Victoria Harbour	400	600	300	" " " "
Waubaushene	700	700	150	" " " "
Coldwater	650	50		

PART III.

SOURCES OF HYDRO-ELECTRIC POWER.

In the southern inland portion of this district water-powers are either very limited in extent or entirely absent, as the rivers all flow from a high table-land lacking in storage through a well-cleared country without important declivities. It is only near the mouths of rivers in this portion of the district that water-powers of any extent are met with.

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Further northward, however, the Severn, Muskoka, Maganetawan, French, Sturgeon and Wahnapitae Rivers have entirely different characteristics, with their sources abounding in lakes and still practically in virgin forest, the result of which is that the water-powers on these rivers are both extensive and valuable, and have already been developed to a considerable extent in the cases of Orillia, Bracebridge, Sturgeon Falls and Sudbury.

In the following table is given the uniform low water flow only, but it should be understood that in all cases enough local pondage can be obtained above the headworks to provide for a considerably increased peak capacity. It is not generally feasible, however, to obtain storage sufficient to materially augment the natural dry weather flow over a greater period than that required to take care of the daily variation in load demands.

TABLE V.

WATER-POWERS IN SOUTH-WESTERN ONTARIO, ON RIVERS TRIBUTARY TO LAKE HURON AND GEORGIAN BAY AS FAR NORTH AS THE FRENCH RIVER.

Water-Power	Head Ft.	Estimated low-water flow, c.f.s.	Minimum 24-hour power, H.P.	Present installation H.P.	Remarks
Maitland River:					
Goderich:					
Piper's	30	140	380	....	Undeveloped; storage for 24 hours.
Black Hole	80	140	1020	....	Proposed development of Maitland R. P. Co.; storage for 24 hours.
Wingham:					
Lower dam	15	32	53	200	Electric light plant; steam auxiliary for 5 months.
Upper dam	10	32	35	130	Flour mill and pump-house; steam for 5 months.
Saugeen River: (main)					
Southampton:					
Denny's dam	13	360	430	200	Saugeen Light & Power Co.'s development.
Possible development	40	360	1310	....	Dam to drown out Denny's, good storage for 24 hours.
Rapids above Paisley	8	....	180	....	.....
Rapids 2½ miles below Walkerton	10	....	225	....	.....
Walkerton:					
Truar's dam	10	250	225	500	Entirely developed.
Rapids above Walkerton	10	...	225	....	.....
Maple Hill	9	....	200	....	Hanover electric light plant; entirely developed.
Hanover	18	245	400	600	.....
Saugeen River, Locherby's Creek:					
Paisley:					
Kissick's dam	12	14	15	100	Paisley electric light plant.
Chesley	10	14	12	250	Crook Bros., furniture; electric light plant (limited daily use.
Rocky Saugeen River:					
Aberdeen	17	70	108	75	Durham electric light plant.
Glen Roden	17	70	108	....	Saw mill.
Hayworth's Falls	31	70	195	....	Markdale electric light plant.
do., possible	60	70	380	....	Possible maximum development.
Traveston	18	70	110	....	Flour mill.
do., possible	50	70	310	....	Possible maximum development.

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Water-Power	Head Ft.	Estimated low-water flow, c.f.s.	Minimum 24-hour power, H.P.	Present installation H.P.	Remarks
Muddy Saugeen River:					
Dalgleish's Rapids	40	....	180	....	.....
Durham:					
McKechnie's dam	13	50	60	80	Flour mill.
do.	12	50	55	....	Undeveloped; below mill.
McGowan's dam	20	50	90	60	Flour mill.
Purdy's Mill	15	30	40	....	.....
Priceville	10	20	18	....	.....
Sauble River:					
Sauble Falls	18	55	90	....	Saw Mill.
Sydenham River:					
Owen Sound:					
Woollen mill	15	25	35	140	.....
Electric Light	33	25	75	125	.....
Saw Mill	14	25	32	....	.....
Inglis mill	37	25	84	....	.....
Beaver River:					
Eugenia Falls	420	30	1060	....	Proposed development of Georgian Bay P. Co.
do., included in above	17	30	46	....	Flesherton electric light plant.
Nottawasaga River:					
Creemore	20	30	54	150	Grist mill and electric lighting plant
Lavender Falls	64	15	90	....	Undeveloped.
Glencairn	25	32	72	....	.....
Horning's Mills	60	10	54	....	Grist mill.
do.	75	10	68	....	42ft. developed.
do.	125	22	250	....	2 miles below village.
Alliston	14	40	52	75	Grist mill ; electric plant.
The Fishery	10	80	72	....	Undeveloped.
Severn River:					
Port Severn	11	750	750	....	.....
Little Chute	10	710	650	....	.....
Big Chute	52	710	3350	....	.....
Ragged Rapids	35	633	2020	1600	Orillia electric light and power plant.
Moon River:					
High Falls / Twin Falls	60	630	3300	....	.....
Curtain Chute	6	630	330	....	.....
Seven Sisters Rapids	20	630	1100	....	.....
Knife Rapids	9	630	510	....	.....
Annie Rooney Rapids	8	630	460	....	.....
Island Portage	15	630	860	....	.....
Muskoka River:					
Moon Chute	10	840	765	....	.....
Bala Falls	20	840	1530	....	.....
Muskoka River, North Branch:					
Bracebridge Falls	51	330	1530	1025	Municipal and manufacturing.
Wolfram's Falls	41	330	1230	....	.....
High Falls	44	330	1320	....	.....
Muskoka River, South Branch:					
South Falls	115	260	2700	....	.....
Catwohey's Falls	35	260	820	....	.....
Seguin River:					
Parry Sound	15	100	140	240	Parry Sound Lumber Co.
do. do.	18	100	160	200	Electric lighting plant.
Maganetawan River:					
Rapids above Byng Inlet.	10	375	340	....	.....
Chute	15	375	510	....	.....
Farm Rapids / Chute	49 / 6	300	1500	....	.....
E. Snye dam	14	300	380	....	.....
Mountain Portage	8	300	220	....	.....
Canal Rapids / Deer Lake Dam	18 / 9	300	740	....	.....
Lower Burnt Chute	38	260	900	....	.....
Upper Burnt Chute	30	260	710	....	.....
Jacob's Rapids	15	250	340	....	.....
Ross' Rapids	7	240	150	....	.....
Poverty Bay Rapids	19	240	410	....	.....
Ahmic Lake Dam and Kneopfle's Rapids	22	240	480	....	.....
Maganetawan	10	140	130	100	Grist and saw mill.
Burk's Falls	28	100	250	500	Knight Bros.

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Water-Power	Head Ft.	Estimated low-water flow, c.f.s.	Minimum 24-hour power, H.P.	Present installation H.P.	Remarks
Maganetawan River, North Branch:					
Burk's Falls	23	40	80	....	
French River:					
Dalle's Rapids	4½	....	....	....	
Recollet	7	1600	1000	....	
Five Mile Rapids	19	1600	2750	....	
Chaudiere	25	1600	3650	....	
South River:					
Chapman's Chute and Rapids	27	110	270	....	
McNab's Chute	43	110	780	....	
Campbell's Chute	35				
Powassan Chute	32	90	260	....	
Ragged Chute	22	90	180	....	
South River Station	70	40	250	....	
Sturgeon River:					
Sturgeon Falls	38	910	3150	6500	Imperial Paper Co.
Sandy Falls	8	910	660	....	
Smoky Falls	28	840	2140	....	
Wahnapitae River:					
Secord Township	35	510	1600	....	
do.	37	510	1600	....	
Wahnapitae	54	440	2000	1065	Wahnapitae Power Co.

PART IV.

GENERATION OF POWER.

At the present time there is a large number of small local developments providing electric light and small amounts of power to local consumers, as will be noted by reference to the fifth column, Table V. Of these the most extensive are the developments at Bracebridge, which deliver about 1,000 h.p., all consumed locally.

The only developments in this district which generate electric power and transmit at high potential, are those constructed (a) by the town of Orillia on the Severn River at Ragged Rapids, twenty miles distant, 22,000 volts; and (b) on the Wahnapitae River for Sudbury, ten miles distant, 22,500 volts. In carrying out the construction of the dam, etc., at Ragged Rapids, considerably greater expense was incurred by Orillia than that at first contemplated, and the capitalization at the present time, including some items for water-works and for local distribution, amounts to $250,000 for an installation of 1,600 h.p. in three units of 800, 400 and 400 h.p. respectively; and further expenditures are now contemplated for the construction of a permanent dam and increase of machinery equipment to a total capacity of 2,400 h.p., at a probable cost of $80,000 additional. In spite of excessive investment per h.p., the town is able to furnish power and light at very reasonable rates, as will be seen by reference to Table XXIV. The

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Wahnapitae Power Company has installed a plant on the Wahnapitae River, ten miles from Sudbury, and proposes an ultimate development of 3,200 h.p., with one spare unit additional. The present equipment is one of 800 k.w. in one unit, with a three-phase transmission to Sudbury, where some 200 h.p. is now marketed.

In this district 60-cycle frequency has been chosen for developments estimated upon, owing to the fact that a considerable number of installations are already operating at 60 cycles, and that this is, for lighting purposes, the frequency usually adopted; further, in that section of the district where electric railways are probable, and for which low frequency is desirable, the supply of hydraulic power will be altogether required for other purposes, such as lighting and small motor loads.

A careful study has been made of the present probable demands for electric power in relation to possible water-power developments capable of supplying these demands, and five developments have appeared to be worthy of serious consideration: namely, (1) On the Maitland River near Goderich, 80 feet head; (2) on the Saugeen River at Southampton, 40 feet head; (3) Eugenia Falls, on the Beaver River, 420 feet head; (4) Big Chute, on the Severn River, 52 feet head; and (5) on the South River near Nipissing, 85 feet head.

(1) *Maitland River Development.*—Some four miles east of Goderich on the Maitland River at the Ox Bow a development of 80 feet head can be obtained by the construction of a rather expensive dam, which will provide storage sufficient to take care of any reasonable daily peak load within the limit of the temporary overload capacity.

Surveys and estimates have been made by engineers on behalf of the Maitland River Power Company, and the reports in connection therewith have been examined by an engineer of the Commission, along with studies at the proposed development point, and close estimates of capital cost and annual charges will be found in Tables VI and VII, following.

(2) *Saugeen River Development.*—At Southampton there is at present a small development made by the Saugeen Light and Power Company under 13 feet head, amounting to some 200 h.p., and it is proposed to construct a dam below the Indian Reserve creating a development under 40 feet head, which would drown out the present one above mentioned.

The 24-hour capacity of this plant at low water would be about 1,200 h.p. electrical energy, and a suggested development, as shown in Tables VI and VII, is for 1,333 h.p. net, the storage created by the dam being sufficient to take care of any reasonable daily peak load up to the overload capacity of the generators.

(3) *Beaver River (Eugenia Falls).*—The development proposed at this point, as an independent plant, would probably be for about

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1,000 h.p., which is the estimated 24-hour low-water capacity, but by combining this development with that on the Severn River, about to be described, it is feasible to instal at Eugenia Falls an equipment of 2,267 h.p., with a spare unit of 1,133 added. By this combination, making use of storage capacity, which can easily be created, the above installation can be employed for carrying all the excess of total load in the district dependent on these two plants above 4,000 h.p., continuous power to be drawn from the Severn River development. It will readily be seen that this will reduce operating expenses for the combined system by allowing complete shutting down of this plant for at least 12 hours per day and over Sunday.

(4) *Severn River (Big Chute).*—A development at this point will be less expensive than ordinarily, owing to the small investment necessary for headworks and canal. Although the power available during an occasional low water period may fall slightly below 4,000 h.p., this amount can be safely depended upon during ordinary years, and the estimates are for works of this capacity, with the usual reserve unit. It will be noted in Table VII that estimates of annual charges are given (1) for this development alone, also (2) combined with Eugenia Falls, the idea being that at first the whole district, ultimately to be served by the two power plants just described, can be taken care of by the Severn River development alone. As soon as the market created becomes too large for the capacity of this plant, the Beaver River development would be undertaken to supply the increased demands, working, as just described in sub-section (3), as a peak load carrier for only a portion of each day.

(5) On the South River a small development has been estimated on, for the supply of the industrial demands of North Bay, which might also furnish lighting current for Powassan and Callander.

TABLE VI.

ESTIMATED CAPITAL COST OF POWER DEVELOPMENTS.

Location of water-power.	Net amount of power to be developed, H.P.	Total capital cost.	Cost per H.P.
Maitland River	1,600	$325,000	$203.12
Saugeen River	1,333	250,000	187.53
Beaver River (Eugenia Falls)	2,267	291,000	128.28
Severn River (Big Chute)	4,000	350 000	87.50
South River	750	115,000	153.33

The capital cost in each case includes step-up transformer stations, one reserve generating unit in excess of each of the above-mentioned capacities, and a spare transformer in each station.

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TABLE VII.

ESTIMATED ANNUAL CHARGES ON FULLY DEVELOPED GENERATING PLANTS.

ITEMS	Maitland River	Saugeen River.	South River.	Severn River Big Chute	Severn and Beaver Rivers combined.
Operating expenses, including administration.....	$5,665	$4,840	$4,100	$17,433	$23,713
Maintenance and repairs....	2,754	3,247	2,620	8,571	13,968
Replacement fund.....	2,755	3,247	2,620	8,571	13,968
Interest at 4%.....	13,000	9,984	4,534	14,000	25,640
Total annual charges.....	$24,174	$21,318	$13,874	$48,575	$77,289

The total annual charges on the Maitland River generating plant, including step-up transformer station are divided as follows: Goderich, 692 h.p., low-tension power, $9,298, or $13.44 per h.p. per annum, Clinton, Seaforth and Mitchell, 990 h.p., high-tension power, $14,876, or $15.03 per h.p. per annum.

The charges on the Saugeen River generating and step-up transforming plant are assessed as follows:

Southampton and Port Elgin, 450 h.p., low-tension power, $7,080, or $15.71 per h.p. per annum.

NOTE.—The 450 h.p. for Southampton and Port Elgin (250 and 200 respectively) is considered to represent the sum of the market now supplied and that available for electric power, since it is considered that the new hydro-electric plant will necessitate the removal of the present one.

Shallow Lake, 770 h.p., high-tension power, $14,238, or $18.49 per h.p.

PART V.

TRANSMISSION OF POWER.

In connection with the five hydraulic developments on the Maitland River, Saugeen River, Beaver River, Severn River and South River, detailed estimates of which have been given in Part IV, four main transmission schemes have been chosen as apparently best meeting present demands, and detailed estimates of these have been prepared with the following results:—

(1) The supply of power to Goderich, Clinton, Seaforth and Mitchell is contemplated from the development on the Maitland River. The scheme outlined involves transmission at generator voltage (2,200 volts, 60-cycle) to Goderich, but stepping up to 22,000 volts for transmission to Clinton, Seaforth and Mitchell.

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A high class wooden pole line upon the highways, with telephone wires upon the same poles, is considered as suitable for such a distance.

The table of transmission details shows the capital cost and annual charges on the transmission lines from the step-up transformer station to the step-down stations on the outskirts of the municipalities, and from the power house to Goderich, the service for which requires no transformation. The annual charges include depreciation and repairs, and the item called "Engineering and contingencies," includes interest during construction. The transmission charges are considered as fixed for all loads within the capacity of the line.

The table of transformation details gives particulars concerning the proposed transformer stations. The step-up station building would be built full size at the outset, but equipment would be installed as required. In the case of Seaforth, one set of transformers and equipment would be installed for half-load, so arranged that when this capacity is exceeded the full equipment would be installed. In the other two cases, no division of equipment is considered feasible, and the charges are, therefore, fixed for all loads. As in previous reports, full load is 25 per cent. increase over the present estimated demand. The transformation charges provide for municipal taxes on building, insurance, depreciation, and 20 per cent. for engineering, contingencies and interest during construction.

The summation sheet contains the charges for transmission, transformation and administration, chargeable to each municipality, added to which in each case is the cost of power at the generating station. This cost includes in the case of Goderich the transmission line losses only, but for the other municipalities, transmission line and transformer losses.

The final column of costs is for 24-hour power at low-tension busbars of the municipal sub-stations, or in the case of Goderich, delivered at the town limits. It appears that the supply of anything less than three-quarter load is not feasible, in this district.

In the following table is shown in condensed form the total investment, annual charges and cost of power at the muncipal sub-stations (sub-stations included).

TABLE XI.

	Full load.	¾ load.	½ load.
Total horse-power distributed	1,562	1,250	781
Total investment including step-down transformer stations	$68,770.00	$68,770.00	$64,122.00
Investment per H.P. delivered	44.03	55.02	82.10
Total annual repairs, depreciation, and operation and administration	5,407.00	5,407.00	5,055 00
Annual interest, 4% of investment	2,751.00	2,751.00	2,595.00
Total annual charges	$8,158.00	$8,158.00	$7,650.00
Cost of 24-hour-power per H.P. per annum, including line and step-down transformer losses:			
Goderich	$16.44	$18.75	$26.04
Clinton	22.08	25.68	36.18
Seaforth	21.03	25.43	33.10
Mitchell	26.47	31.16	44.68

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TABLE IX.—MA

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MUNICIPALITY.	Capacity K.W.	CA: Building.
Mitchell	190	$ 925
	145	925
	95	925
Seaforth	330	1,100
	250	1,100
	165	1,100
Clinton	190	925
	45	925
	95	925

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MUNICIPALITY.	
Goderich.....	4,
Clinton.....	2,
Seaforth.....	2
Mitchell.....	2

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(2) The Saugeen River at Southampton presents the natural source of supply for Southampton, Port Elgin, and the Shallow Lake Cement Co., 17 miles distant. Southampton's estimated demand of 250 h.p. would be supplied from the power-house at generator voltage, and Port Elgin also would only require a transmission at generator voltage over the five miles intervening. The cost of this transmission over and above the cost of ordinary local distribution will be found by referring to Table XXII of this report to be $4.55 per h.p.; this amount added to $15.71, the cost of power at the generating station for Southampton gives a cost at Port Elgin of $20.26 per h.p. per annum, 24-hour power. This local transmission would require a capital investment of $8,000. The power at Southampton station is generated 60 cycles at 2,200 volts, and the transmission line to Shallow Lake is estimated upon as operating at 22,000 volts, using high class wood pole construction on the highways, with telephone line on the same poles.

In the following table will be found the capital cost and annual charges on the transmission line required for Shallow Lake.

TABLE XII.

Distance	17 miles.	
Capital cost per mile, including telephone	$919	
Engineering, contingencies and interest during construction	184	
Total capital cost per mile	$ 1,103	
Grand Total	18,750	
Interest at 4%	750	
Repairs, depreciation, operation, etc	657	
Total annual charges	$ 1,407	
Annual transmission charges on a delivery of 710 H.P., per 24-hour H.P	$ 1.98	

The capital cost of and annual charges in connection with the step-down transformer station at Shallow Lake are given in the following table:—

TABLE XIII.

Building		$ 1,600.00
Electrical equipment		12,000.00
Total capital cost		$ 13,600.00
Depreciation and repairs:—		
Building, 1%	$	16.00
Equipment, 7%		840.00
Taxes on building, 2%		32.00
Insurance:—		
Building, 30c. per $100		4.80
Equipment, 40c. per $100		48.00
Interest on investment, 4%		544.00
Total annual charges		$ 1,484.80
Annual transformation charges, on a delivery of 710 H.P., per H.P		2.09
The total cost of power at Shallow Lake would be as follows:—		
High-tension power at generating station, per H.P. (including line and transformer losses)	$	19.84
Transmission, per H.P		1.98
Transformation, per H.P		2.09
Administration, per H.P		.60
Annual cost per H.P. of 24-hour power, transformed to voltage suitable for motors	$	24.51

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(3) The demands for power in the towns along and adjacent to the south shore of Georgian Bay can be met by the development of water-power at the Big Chute on the Severn River and a subsequent one at Eugenia Falls on the Beaver River, as described in Part IV.

While this might be done by separate transmission systems each covering its own particular territory, it is considered that it will be much more advantageous, economical and efficient if the two developments are combined under one management, and transmission lines so constructed as to admit of the two power stations being operated in parallel. The considerations which show this combination to be highly favorable are: That by so doing practically all the reserve machinery can be installed at Eugenia Falls at a less cost per h.p., owing to the high head; that the parallel operation of the two power houses at widely distant points of a transmission line covering the whole district affords a comparatively high factor of safety with a minimum cost of line construction; and also that the storage possibilities at Eugenia Falls enable that station to be operated at a high output for a short period of each day, and to be closed down during the remainder of each twenty-four hours; from all of which it is evident that power can be developed and delivered by this combination at a considerably less cost than if two separate development and transmission schemes were undertaken.

It has already been noted that so long as the district is capable of using only a portion of the power herein estimated upon the development at the Big Chute alone would be sufficient.

The transmission details following, Table XIV, show the capital costs and annual charges, including interest, depreciation, taxes on right of way, etc. The item called "engineering and contingencies" includes interest during construction. A single high-class wood pole line with a private right of way throughout, following the railways wherever feasible, is provided for, with a telephone line also installed on the power poles.

The transformation details, Table XV, show the estimated required capital outlay for municipal transformer stations, and the resulting annual capital charges and operating expenses. It is, in the case of the larger stations, quite feasible to install transformer capacity as needed, thus partially varying the investment and charges with the load requirements; but the buildings are estimated upon as built at the outset for full future load conditions (25 per cent. advance on present estimated demand) with equipment installed as needed.

The transformation estimates include municipal taxes on site and buildings and an allowance of 20 per cent. for engineering, contingencies and interest during construction.

The summation sheet (Table XVI) shows the charges due to the various sections of the service sub-divided amongst the various municipalities. Two-thirds of the total general administration expenses is charged to transmission and transformation, the remainder being included in the annual operating expenses of the generating plant. The

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column showing the cost of power at the generating plants includes line and sub-station transformer losses, and is based on a price of $12.00 per 24-hour h.p. per annum at the high-tension bus-bars of the step-up transformer station. (See Tables VI and VII.)

In the following table is shown in condensed form the total investment, annual charges and cost of power at the municipal sub-stations (sub-stations included).

TABLE XVII.

	Full load.	¾ load.	½ load.
Total horse-power distributed	6,375	4,781	3,187
Total investment, including step-down and inter-switching stations	$436,437.00	$404,355.00	$373,579.00
Investment per H.P. delivered	68.46	84.58	117.22
Total annual repairs, depreciation, patrolling, operation and administration	37,840.00	33,137.00	29,101.00
Annual interest, 4% of investment	17,457.00	16,174.00	14,943.00
Total annual charges	$55,297.00	$49,311.00	$44,044.00

Cost of 24-hour power per h.p. per annum at low-tension bus-bars of step-down transformer sub-stations:

Owen Sound	$ 20.22	$ 21.55	$ 26.90
Meaford	21.00	22.39	25.36
Collingwood	21.96	23.91	27.99
Barrie	25.27	28.18	34.23
Midland	17.99	18.67	20.47
*Penetang	21.09	22.02	24.37
Victoria Harbour	18.63	19.43	21.21
Waubaushene	21.07	22.31	24.33
*Coldwater	26.27	28.49	32.25

*It is not considered advisable to build high-tension lines to Penetang or Coldwater, but to have them participate in the scheme of secondary transmission as given in Table XXII, from which the cost of power to Penetang will be found to be the following amounts greater than the cost of power at Midland, three miles distant:—

Full load	250 H.P.	$3.10 additional per H.P. per year.
¾ load	187 H.P.	3.35 additional per H.P. per year.
½ load	125 H.P.	3.90 additional per H.P. per year.

Additional cost to Coldwater over that at Waubaushene, four miles distant:—

Full load	100 H.P.	$5.20 additional per H.P. per year.
¾ load	75 H.P.	6.18 additional per H.P. per year.
½ load	50 H.P.	7.92 additional per H.P. per year.

The above distribution lines will cost $4,800 and $6,000 respectively.

BRANCH TO SHELBURNE AND DUNDALK.

A minor transmission is also estimated upon for the supply of Dundalk and Shelburne from Eugenia Falls, with separate transformers at this generating station for 22,000 volts. A telephone line on the power poles is provided for, but no right of way allowance.

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In the following table will be found the results of this estimate:—

TABLE XVIII.

Showing capital cost and annual charges on 22,000 volt, 60-cycle, transmission from Eugenia Falls to Dundalk and Shelburne.

Total horse-power transmitted:— Shelburne, 175 H.P.; Dundalk, 125 H.P.	300
Total investment, including step-down transformer stations	$20,516.00
Investment per H.P. delivered	68.39
Total annual repairs, depreciation, operation and administration	1,547.00
Interest on investment at 4%	821.00
Total annual charges	$2,368 00

	Shelburne	Dundalk
Cost of 24-hour power per H.P. per annum at power-house, including line and transformer losses	$13.15	$13.05
Cost of transmitting and transforming	13.06	3.80
Total cost of 24-hour power per H.P.	$26.21	$16.85
If only 250 H.P. were contracted for	29.97	18.20
If only 200 H.P. were contracted for	33.74	19.75

As an alternative source of supply of power for these towns, attention is called to a small water-power near Horning's Mills, on a branch of the Nottawasaga River; although there is but small flow, the development can be made under 125 feet head, and, so made, would be capable of providing 250 h.p. twenty-four hour power, or, due to its good daily pondage conditions, the plant might be able to supply a peak demand of, say, 500 h.p.

(4) The most convenient immediately available source of power for North Bay, Powassan and Callander is considered to be a development on the South River. The estimates for a 22,000-volt transmission to Powassan and North Bay are here given. They are for a wood pole line along the highways and railways, with telephone wires on the power poles. The same allowance for engineering, contingencies, and interest during construction have been made as in previous cases. The final cost per h.p. is derived from charges which should be considered as fixed for lesser loads; in other words, the charges per h.p. will be inversely proportional to the demands up to the 750 h.p. mentioned.

TABLE XIX.

Showing capital cost and annual charges on 22,000-volt, 60-cycle, three-phase transmission from South River development to Powassan and North Bay.

Total amount of power transmitted:— Powassan, 125 H.P. (estimated); North Bay, 625	H.P. 750
Total investment, including step-down transformer stations	$ 50,500.00
Investment per horse-power delivered	67.33
Total annual repairs, depreciation, operation and administration	3,135.00
Interest on investment at 4%	2,020.00
Total annual charges	$ 5,155.00

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	Powassan.	North Bay
Cost of 24-hour power per H.P. per annum at power-house, including line and transformer losses	$19.80	$20.10
Cost of transmitting and transforming	5.09	8.25
Total cost of 24-hour power per H.P. per annum	$24.89	$28.35
Cost per H.P. if only ¾ of the above quantities were used	33.19	39.80

NIAGARA EXTENSIONS.

As intimated in Part I of this report, it is proposed to supply certain towns, there mentioned, from the Niagara transmission systems.

(a) The estimates for a secondary 22,000-volt transmission from Berlin through Elmira to Elora are herewith submitted. The estimate is for wood pole line without right of way, telephone on power poles. Elora is at present supplied with lighting current from a steam station in Fergus, and it is proposed that the present lines between these two towns be used up to their capacity for the supply of low-tension, 2,200-volt power to Fergus from a common transformer station in Elora.

TABLE XX.

Showing capital cost and annual charges on secondary transmission, Berlin-Waterloo sub-station to Elmira, Elora and Fergus.

	Full load.	¾ load.	½ load.
Total horse-power transmitted	750	563	375
Total investment, including step-down transformer stations	$39,952.00	$39,952.00	$39,952.00
Investment per H.P. delivered	53.27	71.03	106.53
Total annual repairs, depreciation, operation and administration	$2,837.00	$2,816.00	$2,783.00
Interest on investment at 4%	1,598.00	1,598.00	1,598.00
Total annual charges	$4,435.00	$4,414.00	$4,381.00
Cost of 24-hour power at Berlin-Waterloo sub-station, per H.P. per year	$17.36	$17.82	$19.27
Cost of 24-hour power at low-tension bus-bars of sub-stations, per H.P. per year:			
Elmira	$24.10	$25.80	$30.28
Elora	26.56	29.47	36.84
Fergus	29.91	33.37	41.44

(b) The supply of 1,600 h.p. required by the Toronto and York Radial Railway Company for the operation of the Metropolitan division can be reasonably combined with the power demands of Aurora and Newmarket. It is assumed that one-half of this quantity will be required at the Bond Lake station, and that the other half will be delivered at Newmarket for further transmission to the upper section. A 60,000-volt extension of the Niagara District transmission lines is estimated on, from Toronto, the results of which are as follows:—

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TABLE XXI.

Showing capital cost and annual charges on 60-000-volt extension of transmission line, Toronto to Aurora and Newmarket.

	Full load.	¾ load.	½ load.
Total horse-power distributed	3,162	2,372	1,581
Total investment, including step-down transformer stations	$116,130.00	$101,900.00	$87,430.00
Investment per H.P. delivered	36.73	42.97	55.30
Total annual repairs, depreciation, patrolling, operation and administration	8,915.00	7,790.00	5,661.00
Interest on investment at 4%	4,645.00	4,076.00	3,497.00
Total annual charges	$13,560.00	$11,866.00	$9,158.00
Cost of 24-hour high-tension power at Toronto transformer station, with allowances for switching protection, and housing, per horse-power per year	$16.03	$ 16.45	$ 16.68
Cost of 24-hour power at low-tension bus-bars of municipal sub-stations per horse-power per year:			
Newmarket	$20.94	$22.72	$24.05
Aurora	22.76	24.63	25.74
Bond Lake	20.34	21.24	22.12

This transmission is over a wood pole line with telephone lines on power poles, and with fenced right of way.

INDIVIDUAL TRANSMISSION.

The various sub-stations have been estimated on the basis of transformation down to 2,200 volts, but the cost of distribution of power at this voltage will be dealt with in Part VI. Many instances arise, however, in which it is desired to supply a single large consumer or a small municipality at some distance from a sub-station. When this is the case the following table may be made use of. The total cost of power to such a consumer is ascertained by adding the rate per h.p. from this table to the cost of power at the nearest municipal sub-station. The charges for such a branch transmission do not include any allowance for right of way or telephone, it being assumed that the highways would be available for such low voltage lines.

TABLE XXII.

Showing cost of distribution from municipal sub-station to an individual consumer, not covered by local distribution.

Distance in miles from Municipal substation.	Cost per horse-power per annum for the delivery of various amounts of power.							
	50 HP	75 HP	100 HP	150 HP	200 HP	250 HP	300 HP	
2	$5.58	$4.20	$3.53	$2.92	$2.74	$2.60	$2.51	2,200 Volts
3	6.89	5.20	4.41	3.60	3.25	3.10	3.03	
4	7.92	6.18	5.20	4.27	3.93	3.72	3.86	
5	8.87	7.18	5.98	4.96	4.55	4.32	4.17	
6	10.20	8.24	6.77	5.38	5.13	4.60	4.43	
8	14.10	10.14	8.40	6.97	6.24	5.79	5.58	11,000 Volts
10	16.12	12.13	9.54	8.31	7.68	6.96	6 17	
12	18.76	14.03	11.12	10.12	8.42	7.96	7.22	16,500 Volts
15	22.74	17.08	13.48	10.89	9.35	8.84	8.32	

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PART VI.

DISTRIBUTION OF POWER.

The cost of distribution from the municipal sub-stations to the the consumers' premises varies widely with different conditions and depends upon the distances involved, the magnitude of the demands of individual consumers and the grouping of these consumers.

This cost of distribution will not necessarily, however, give the increase of cost to the consumer above that paid for the power by the municipality unless a method of charging be chosen which will take into account the difference between the sum of the consumers' maximum demands and the maximum demand on the station. If the charging rate for power were one composed of a flat rate based on maximum demand plus a rate per k.w.-hour or h.p.-hour actually registered by meter, then it would be approximately correct to say that the combined rate per h.p. to the consumer should be the same as the cost of power at the sub-station plus the cost per h.p. of the distribution service. Besides this the ordinary municipality has such various means of modifying the rates for power, such as limited-hour contracts with motor users, contracts with summer users of electric power, etc., that fair rates could only be established after a careful study of the actual conditions after operations were begun. Under average conditions in a town demanding 1,000 h.p. or over, it could reasonably be expected that 10-hour power could be sold at the same or even a lower rate, if based on maximum demand, than that charged the municipality for 24-hour power at the sub-stations. In other words, the municipality might expect to profit sufficiently from overlapping peaks, 24-hour power for lighting, pumping, general motor users, etc., to pay the cost of its distribution.

The cost of a distribution system for the town of Collingwood has been estimated on, including such power service transformers as would probably be required; and it is found that a capital expenditure of $31,000 would be necessary. This would only include the feeding of the necessary lighting current into the existing primary lighting network at suitable points and in no way covers lighting distribution. The substitution of 60-cycle transformers for those already in use in this town would be the only extra expenditure required for lighting distribution. The annual interest, depreciation and operation charges attendant upon such a power investment as above outlined would be $5,713 for the distribution of 1,250 h.p., or at the rate of $4.57 per h.p. per year, which, added to $23.90 per h.p., the cost of low-tension power at the sub-station, gives an average rate for distributed power of $28.47 per h.p. per year for 24-hour power, without any allowance for overlapping.

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For the smaller towns the cost of the distribution service would not be likely to exceed the cost per h.p. found in Collingwood, but the opportunities for modifying the selling price would not be so extensive. It may be said, however, that the actual selling price of 10-hour power to the consumer would not be appreciably greater than the cost of 24-hour power to the municipality at the main sub-station, as given in this report.

PART VII.

MOTOR INSTALLATIONS.

To complete the information regarding the cost of electric power to the consumer, the following table is given, showing the cost of induction motor service per h.p. per year.

TABLE XXIII.

Capital cost and annual charges on motor installations, polyphase, 60-cycle, induction motors.

Capacity H.P.	Capital cost per H.P. installed	ANNUAL CHARGES			
		Interest 5%	Depreciation and repairs, 6%	Oil, care and operation.	Total per HP per annum.
5	$39.00	$1.95	$2.34	$4.00	$8.29
10	36.00	1.80	2.16	3.00	6.96
15	30.00	1.50	1.80	2.50	5.80
25	25.00	1.25	1.50	2.00	4.75
35	22.00	1.10	1.32	1.75	4.17
50	20.00	1.00	1.20	1.50	3.70
75	19.00	.95	1.14	1.25	3.34
100	17.00	.85	1.02	1.00	2.87
150	15.00	.75	.90	.80	2.45
200	14.00	.70	.84	.70	2.24

By combining the costs given in this table with the cost of distributed power, as indicated in Part VI, the final or total charge per h.p. per year will be obtained.

PART VIII.

SINKING FUND.

In the above estimates for transmission and transformation, depreciation and replacement have been provided for which would replace the different classes of plant in periods ranging from 15 to 30 years.

The charges would, therefore, amply serve the purpose of any sinking fund which might be considered needful. In the case of the

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generating plant estimates, however, these charges would not be sufficient for such a purpose in the so-called permanent portions of the development, comprising the dam, headworks, power-house, etc.

A forty-year sinking fund to cover these portions of the developments, amounting, on the average, to about $65 expenditure per h.p. of capacity, would require a charge of $0.77 per h.p. to repay this expenditure in forty years, interest being calculated at 4 per cent.

PART IX.

EXISTING RATES.

In Table XXIV, following, will be found a statement of the lighting and power rates in a number of municipalities throughout the district. The municipally-owned steam plants show rates uniformly lower than Aurora and Seaforth, the two steam plants under private control. Sudbury has a municipal distribution, but it pays $33.00 per h.p. for its water-generated power supply.

Bracebridge and Sturgeon Falls have locally generated hydro-electric power.

TABLE XXIV.

Municipality	Commercial incandescent lighting		Residential incandescent lighting.		Street lighting per arc per year.	Power for motors, flat rate per H.P. per year.
	Meter rate per K.W. hour	Flat rate per year.	Meter rate per K.W. hour.	Flat rate per year.		
Goderich (Municipal)	9c.	.....	9c.	.....	$40.00 (moonlight)	.....
Owen Sound (Municipal)	7½c. to 10c.	.....	7½c. to 10c.	.....	$51.00 (moonlight)	.....
Collingwood (Municipal)	7 to 10c.	.....	7 to 10c.	.....	$60.00	.....
Newmarket (Municipal)	9c.	.....	9c.	.....	$8.50, 32 c.p.	.....
Aurora	.....	$7.50 and down.	.....	$7.50 and down.	.....	.....
Orillia (Municipal)	8c.	$2.40	.....	$3.36	$40.00 (moonlight)	$16.00
Seaforth	11c. and down.	.....	11c. and down.	.....	$69.50	.....
Bracebridge (Municipal)	.....	$2.25	.....	$2.25	$10.00, 50 c.p.	$12.50 to $16.00
Sudbury (Municipal)	10c.	.....	10c.	.....	.....	$25.00 to $33.00 Wahnapitae P. Co.
Sturgeon Falls	8c.	$3.00	8c.	$3.00	$15.00, 50 c.p.	

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PART X.

STEAM POWER.

In order to institute a comparison between the cost of electric power as has just been set forth and the cost of power generated by steam or producer gas, the following tables have been compiled after a careful study of data available in technical journals and also from data collected by the Commission's engineers in various towns within the district under consideration. The capital costs have been compiled from information supplied by various makers of engines and other machinery. The tables represent average working conditions and assume a high class installation.

TABLE XXV.

STEAM POWER PLANTS.

Showing capital costs of plants installed and annual costs of power per brake horse-power.

Size of Plant, H.P.	Capital Cost of Plant per H.P. installed.			Annual Cost of 10-hour Power per B.H.P.	Annual Cost of 24-hour Power per B.H.P.
	Engines, Boilers, etc., installed.	Buildings.	Total.		
	CLASS I.—Engines: Simple, slide-valve, non-condensing. Boilers: Return tubular.				
10	$66.00	$40.00	$106.00	$91.16	$180.76
20	56.00	37.00	93.00	76.31	151.48
30	48.70	35.00	83.70	66.46	131.68
40	44.75	33.50	78.25	59.49	117.74
50	43.00	31.00	74.00	53.95	106.46
	CLASS II.—Engines: Simple, Corliss, non-condensing. Boilers: Return tubular.				
30	70.70	35.00	105.70	61.14	117.70
40	62.85	33.50	96.35	55.50	107.10
50	59.00	31.00	90.00	50.70	97.73
60	56.00	30.00	86.70	47.42	91.34
80	50.00	27.50	77.50	43.86	85.41
100	44.60	25.00	69.60	40.55	79.19
	CLASS III.—Engines: Compound, Corliss, condensing. Boilers: Return tubular with reserve capacity.				
100	63.40	28.00	91.40	33.18	60.05
150	53.70	24.00	77.70	29.83	54.63
200	50.10	20.00	70.10	28.14	51.72
300	45.90	18.00	63.90	26.27	48.83
400	43.55	16.00	59.55	24.84	46.12
500	41.25	14.00	55.25	23.73	44.21
750	40.50	13.00	53.50	23.56	44.02
1000	39.00	12.00	51.00	23.26	43.71
	CLASS IV.—Engines: Compound, Corliss, condensing. Boilers: Water-tube, with reserve capacity.				
300	55.20	18.00	73.20	25.77	46.32
400	51.50	16.00	67.50	24.18	43.61
500	49.40	14.00	63.40	23.19	42.03
750	46.80	13.00	59.70	22.88	41.56
1000	44.30	12.00	56.80	22.47	41.11

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NOTE.—Annual costs include interest at 5 per cent., depreciation and repairs on plant, oil and waste, labor and fuel (coal at $4.00 per ton). Brake horse-power is the mechanical power at engine shaft.

It will be noted that for a consumer requiring a large installation, operating for ten hours only, there appears to be little advantage to be derived from the use of transmitted electric power, provided the power is not to be distributed throughout a consumer's buildings by a complicated system of shafting, belts, etc. But in the majority of cases this condition obtains, and herein lies one of the specific advantages of electric power. Motors can be installed on each floor of the factory, or even on each machine, with but little loss in efficiency, and only such motors as are required to drive the machinery in use from time to time need be operated. In many cases due to this fact the total electric power consumption of a large factory would be reduced from 25 per cent. to 50 per cent. below that which is required under steam operation, working from a central station.

Again, where electric power is available throughout the 24 hours many industries will work night and day, thereby effecting a great economy, as is evidenced by a comparison of the cost of 24-hour steam or producer gas power with 24-hour electric power.

Perhaps the most striking advantage to be derived from the use of electric power as compared with other power, is that the small consumer can obtain power at a rate which should not be appreciably greater than that made to the large consumer, although the present practice in selling electric power is to discriminate against the small consumer for the reason that electric power prices made by private companies are not based on cost of service, but are merely made with a view to displacing steam.

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PART XI.

PRODUCER GAS POWER.

TABLE XXVI.

Showing capital costs of producer gas plants installed and annual costs of power per brake horse-power.

Size of Plant, H.P.	Capital Cost of Plant per H.P. Installed.			Annual Cost of 10-hour Power per B.H.P.	Annual Cost of 24-hour Power per B.H.P.
	Machinery, etc.	Buildings.	Total.		
10	$137.00	$40.00	$177.00	$53.48	$90.02
20	110.00	36.00	146.00	44.47	75.22
30	93.00	33.00	126.00	38.73	65.99
40	84.50	29.00	113.50	35.05	59.85
50	80.00	26.00	106.00	32.27	55.22
60	79.00	24.00	103.00	30.49	52.03
80	78.20	22.00	100.20	28 70	48.95
100	77.50	20.00	97.50	27.05	45.40
150	76.00	19.00	95.00	25.87	43.17
200	74.00	17.00	91.00	24.95	41.78
300	73.00	16.00	89.00	24.24	40.40
400	71.50	14.00	85.50	23.41	39.03
500	70.00	12.00	82.00	22.54	37.54
750	67.50	10.00	77.50	21.55	35.99
1000	65.00	8.00	73.00	20.46	34.66

NOTE.—Annual costs include: Interest at 5 per cent., depreciation and repairs on plant, oil and waste, labor and fuel (bituminous coal at $4.00 and anthracite coal at $5.00 per ton).

A reference to Table XXIV will show that the cost of power developed by producer-gas plants and gas engines is less than that produced by steam plants of the same capacity. It may be said, however, that up to the present no very large installations of suction producers have been made, 250 to 300 horse-power being about the maximum. But this has been provided for in the table by assuming that the larger plants will be made up of several units, each unit being not greater than 350 h.p. capacity. While operation of producer-gas plants has not been going on many years, and complete knowledge on the subject is not available, with the information at hand it is believed that in many situations this form of power producer will be found more economical than a steam plant, and, therefore, a closer competitor of hydro-electric power. It must be remembered that the same objections hold against the producer-gas plant as those which have been mentioned in reference to steam plants, namely, that 24-hour power costs proportionately more than 10-hour power; that the small consumer does not have the great advantage obtainable by the use of electric power; and also that a central installation in a factory is all that is possible if electric motors are required in various parts of the factory, and the only prime mover available is steam or gas. This

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will make the cost of electric factory operation very expensive, and considerably higher than the power costs shown in Table XVII. Speaking generally, however, it may be said that producer-gas plants have a bright future, and as the design and construction is perfected undoubtedly the capital cost will be reduced and the cost of power lessened.

TABLE XXVII.

Showing the effect on the cost of power of a variation in the price of coal of one-half dollar per ton.

Size of Plant H.P.	Suction Producer Gas.		Steam.		
	10-Hour.	24-Hour.	10-Hour.		24-Hour.
10	$1.15	$2.53	Simple Slide Valve Engine.	$6.14	$13.47
20	1.13	2.46		5.25	11.56
30	1.10	2.40		4.71	10.35
40	1.07	2.33	Simple Automatic non-condensing	3.56	7.84
50	1.04	2.29		3.37	7.41
60	1.01	2.24		3.26	7.16
80	.98	2.18		3.15	6.97
100	.96	2.12		3.12	6.87
150	.94	2.07	Compound Condensing.	1.75	3.85
200	.92	2.02		1.69	3.71
300	.90	1.98		1.62	3.60
400	.88	1.94		1.56	3.44
500	.86	1.89	Compound Condensing; Water-tube Boilers.	1.39	3.05
750	.82	1.81		1.39	3.05
1000	.76	1.72		1.39	3.05

PART XII.

SAVINGS.

In Collingwood, at the present time, about 1,100 h.p. of steam could be economically replaced by about 950 electrical horse-power. The present cost of this steam power in operating expenses alone, allowing for each case of utilization of exhaust steam for heating, etc., is not less than $40,000 per annum. The cost of the 950 e.h.p. to replace it would be, power at $23.90 per h.p., $23,715, and distribution, $5,713, totalling, $28,425. This shows a yearly saving of $11,575.

The savings for the other municipalities would vary with their size, the amount of 24-hour power used, and with their facilities for influencing load factor, etc.

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